Use the Results of Measurements on KBR Facility for Testing of Neutron Data of Main Structural Materials for Fast Reactors

Vladimir **Koscheev[1], *Gennady* Manturov[1], *Vladimir* Pronyaev[2], *Evgeny* Rozhikhin[1], *Mikhail* Semenov[1], *Anatoly* Tsibulya[1]**

1- JSC "SSC RF – IPPE", ,Russia
2 – PI "Atomstandart", Russia

Introduction

A series of k_∞ experiments has been performed on the KBR facility at the IPPE, Russia.

In 2002 the experiments were evaluated according to the ICSBEP rules (as HCI-005).

In this work five critical KBR assemblies were studied in which the central test zone was composed by different structural materials, by components of stainless steel (SS) - Cr, Mn, Fe, Ni, but Zr and Mo as well.

Use of any modern set of nuclear data does not allow to obtain the calculated k_∞ value which would be consistent with experimental results in the limit of estimated errors.

Modifications of neutron cross sections of majors structural materials of the ROSFOND 2010 nuclear data library were made and results of testing of the data are presented.

Modification of Neutron Cross Sections

The following approach was used for modification of neutron cross sections:

- As the basis, the neutron data files of the ROSFOND 2010 (RF10) library were used;
- Latest microscopic cross-section measurements were analyzed;
- Parameters of the first resonances of odd isotopes of Cr, Mn, Fe and Ni are modified.
- Evaluation by Ichihara et al., adopted for JENDL-4.0, are used as a basis for Zr neutron cross section data.

Benchmarks for Testing the Data

Experiments selected from ICSBEP Handbook are divided into five groups (the Lists):

A List 1: The KBR experiments for testing capture cross sections of structural materials.

A List 2: Experiments on the compact critical assemblies with iron reflectors for testing anisotropy of the Fe elastic scattering angular distributions:

- PMF-015, PMF-025, PMF-026, PMF-028, PMF032; HMF-013, HMF-021, HMF-084/7, HMF-084/19.

A List 3: Experiments with a large quantity of SS or Fe in the core and in the reflector for testing the Fe total effect of anisotropy in the elastic scattering and neutron capture:

- PMI002 (ZPR-6/10), HMI001 (ZPR-9/34).

A List 4: Experiments with Mo and Fe:

-PMF-044/1 and HCM-003.

A List 5: Experiments with Ni reflector:

- PMF-014, HMF-003/12, HMF-084/10, HMF-084/22, MCF-004 (ZPR-3/56B).

Critical experiments with large sensitivity to neutron data for Zr at the intermediate or fast energy range are absent.

Codes and Nuclear Data used

The MCNP5 Monte-Carlo code was used for criticality calculations. In addition to the initial RF10 and modified RF10+library, the following data were used in calculations: ENDF-VII.1 (E-71), ENDF/B-VIIIbeta1 (E-8b1), JENDL-4.0 (JL40), JEFF-3.2 (JF32). The library designation used further for reference is shown in parentheses.

The Main Results

The results of C/E-1 differences in k_∞ for named libraries are shown in Figure 1 for the KBR benchmark models sensitive to the capture cross section of the tested materials. The result with ABBN-93 constant's set is also presented in Figure 1 as ABBN93.

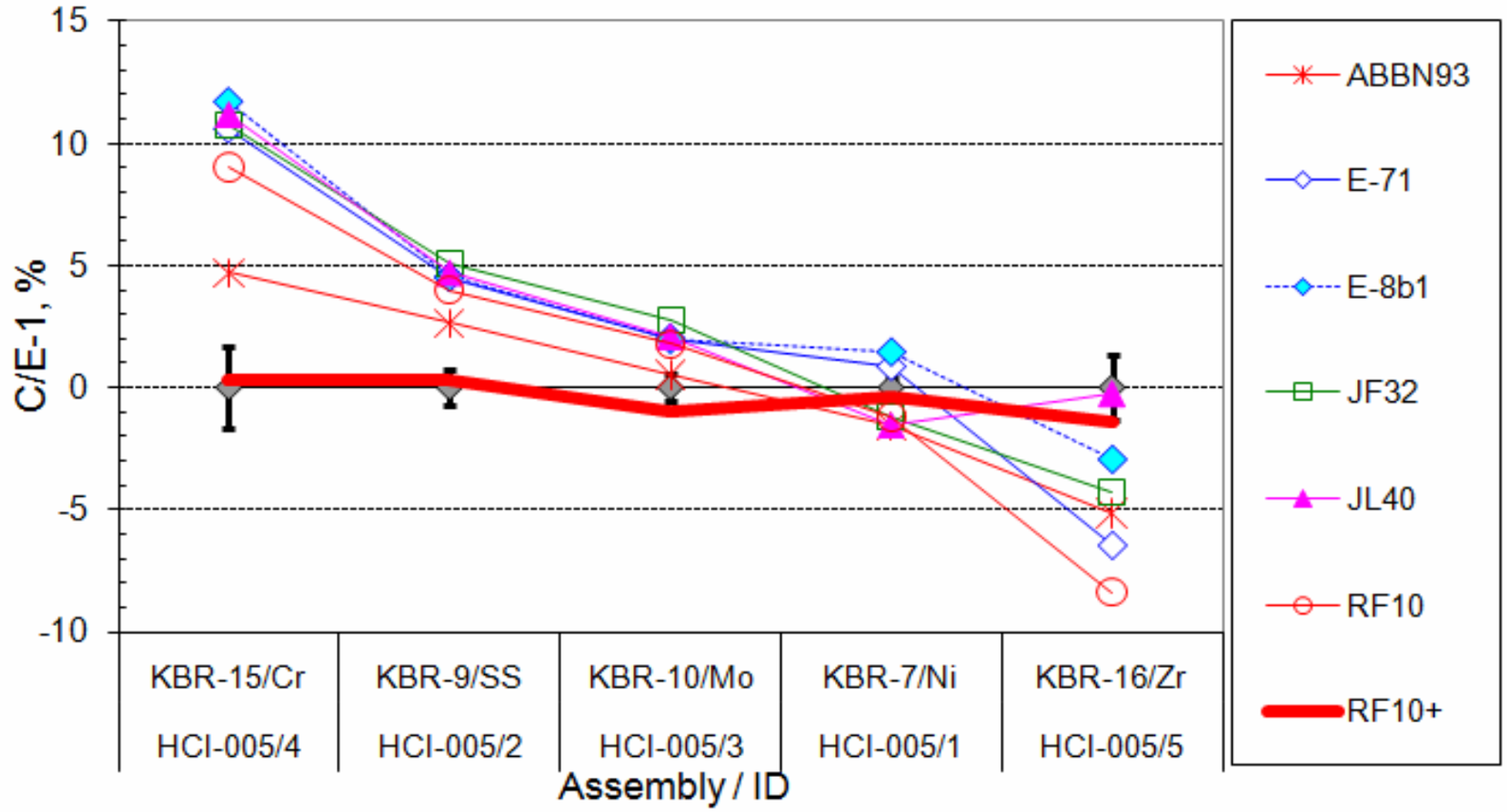

Fig. 1. C/E-1 differences in k_∞ values for HCI-005 benchmarks.

The results of testing of Fe transport cross section in calculation of simple systems with Fe reflector are presented in Figure 2.

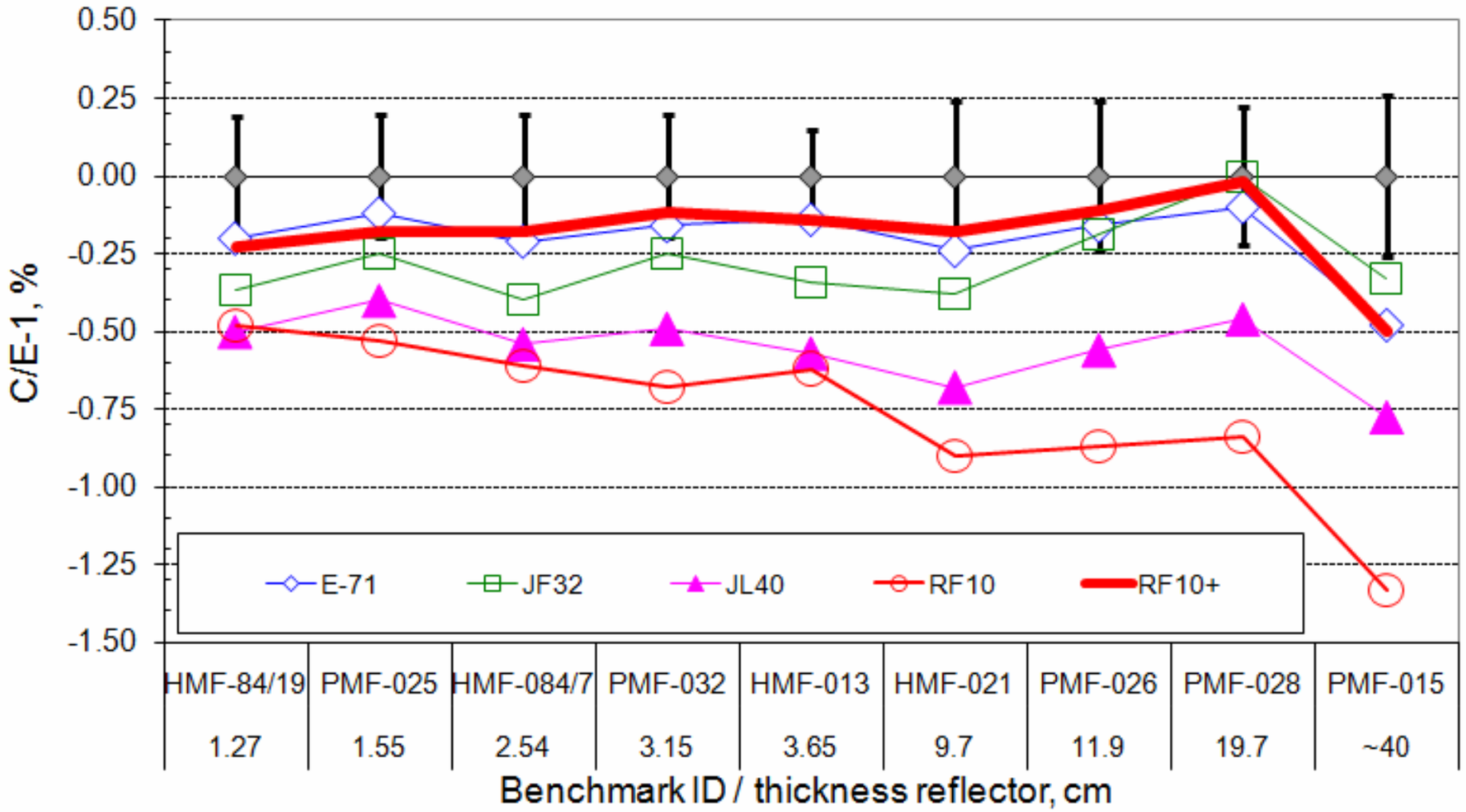

Fig. 2. C/E-1 differences in keff values for benchmarks with iron reflector.

Conclusions

- Use of the modified nuclear data for Cr, Mn, Fe, Ni and Zr structural materials within the ROSFOND neutron data library leads to a significant improvement in C/E ratio for HCI-005 (KBR assemblies) benchmark.
- A significant improvement of agreement between the calculated and evaluated values for a set of keff benchmarks with Fe reflector was observed too.